OPERATOR'S & MAINTENANCE MANUAL

Model 2000

System Pulse Generator

WAVETEK®

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Model 2000

System Pulse Generator

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WAVETEK

WAVETEK SAN DIEGO, INC.
9045 Balboa Ave., San Diego, CA 92123
P. O. Box 85265, San Diego, CA 92138
Tel 619/279-2200 TWX 910/335-2007

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NOTICE

In order to protect entry to:
Reformat EE Proms
Store Checksums
Toggle Clock Boards
the following password has been assigned
12985.

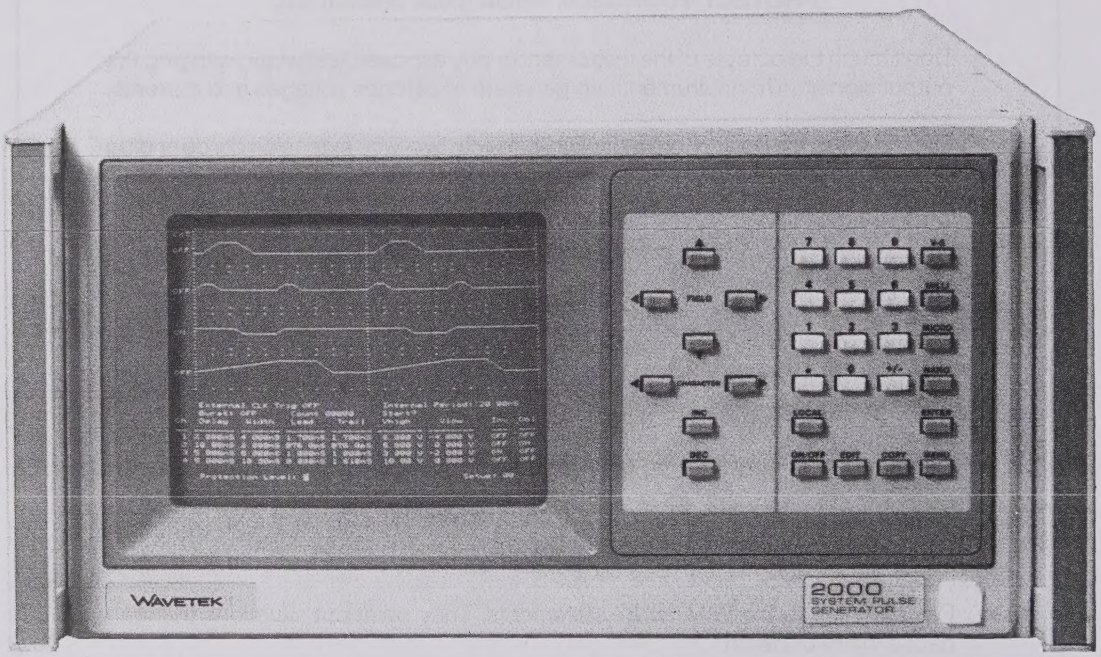
Use this password with care since reformatting the EE Proms can cause loss of stored channel setups, toggle the clock boards, and misalign the software and the appropriate board.

PLEASE REMOVE THIS PAGE
AND FILE AS CONFIDENTIAL INFORMATION

SAFETY FIRST

PROTECT YOURSELF. Follow these precautions:

- Don't touch the outputs of the instrument or any exposed test wiring carrying the output signals. This instrument can generate hazardous voltages and currents.
- Don't bypass the power cord's ground lead with two-wire extension cords or plug adaptors.
- Don't disconnect the green and yellow safety-earth-ground wire that connects the ground lug of the power receptacle to the chassis ground terminal (marked with ⏚ or ⚠).
- Don't hold your eyes extremely close to an rf output for a long time. The normally nonhazardous low-power rf energy generated by the instrument could possibly cause eye injury.
- Don't plug in the power cord until directed to by the installation instructions.
- Don't repair the instrument unless you are a qualified electronics technician and know how to work with hazardous voltages.
- Pay attention to the **WARNING** statements. They point out situations that can cause injury or death.
- Pay attention to the CAUTION statements. They point out situations that can cause equipment damage.



Model 2000 System Pulse Generator

SECTION 1
GENERAL DESCRIPTION

1.1 INTRODUCTION

This manual applies to the EHE Model 2000 Programmable Pulse Generator which includes Options 2005 and 2010 (5 and 10V, variable transition time modules), 2005E and 2010E (5 and 10V, variable transition time modules with extended width and delay ranges), and 2002FE and 2005FE (2 and 5V high speed, fixed transition time modules with extended width and delay ranges).

1.2 MODEL 2000 FEATURES

The instrument is a fully programmable, fast rise time, high performance pulse generator with 200 MHz operation and sub-nanosecond rise times. It is intended for automatic test equipment applications. Some typical uses are:

- Fast discrete device testing
- Integrated circuit testing
- Module and subassembly testing
- Subsystem testing

The mainframe may contain any combination of up to four output channels. Each channel requires a channel board and an output driver module. Six types of output modules (2002FE, 2005, 2005E, 2005FE, 2010, and 2010E) are available for each channel. All modules have 50Ω output and are backmatched to absorb a high proportion of reflections from a mismatched load.

The internal clock rate is the same for all channels, however, each channel can be driven by independent external channel drive inputs. A word/pattern generator can be used as the signal source. All programmable pulse parameters can be different for each channel.

The instrument is designed for fully automatic operation from either IEEE-488 or RS-232-C interfaces. The operator also has full, manual, menu-driven control of pulse parameters.

The front panel CRT displays a graphic representation of the output waveforms from each of the installed channels as they appear at the output connector. It also shows instrument mode and the values of all pulse parameters. Editing facilities allow setup modification without affecting the output pulse being generated at that time.

Up to forty setups may be stored in the instrument's internal memory registers, the first five are non-volatile. A setup is defined as the set of all the pulse parameter values for four channels.

Burst mode allows a stream of between 1 and 65,535 pulses to be generated. The inverted pulse mode allows duty cycles approaching 100% to be realized. The double pulse mode will output the first pulse at the start of the pulse repetition period and the second after a specified delay.

1.3 LOCATION OF MODULES

Modules are mounted in the chassis according to the transition speed of the module. The faster the module, the higher the channel number. The modules (in order of increasing module speed) are installed as follows: 2010, 2010E, 2005, 2005E, 2005FE and 2002FE.

1.4 SPECIFICATIONS

OUTPUT CHANNELS

Variable Transition

Options P2005, P2005E, P2010, P2010E. Refer to tables 1-1 and 1-2.

Fixed Edge Speed

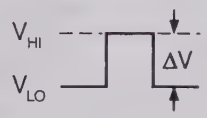
Options P2002FE and P2005FE. Refer to tables 1-1 and 1-2.

AVAILABLE PULSE VOLTAGE

Refer to table 1-1. To select the proper module:

1) Find your pulse amplitude in the Pulse Amplitude column.
2) Check that the required V_{HI} is available.
3) Calculate your V_{LO} with $V_{LO} = V_{HI} - \Delta V$.

Values given are in volts.



GENERAL

Burst Mode: 1 and up to 65,535 pulses per burst. The maximum number is frequency range dependent.
Burst Start Input: TTL compatible, positive edge triggered.
Burst Complete Output: 0V for duration of burst. >+1.0V on completion.
External Clock Drive Input: Positive edge triggered levels <0.3V, >1.0V, 50Ω termination. Max level 5.5V. Max frequency 200 MHz.
External Channel Drive Inputs: ECL level inputs, -1.6V to -0.8 typical (0V and -2V max). Max frequency 200 MHz.
Trigger Output: Positive edge at time T0 is +1.0V into 50Ω, >2.0V into Hi-Z. (Must be terminated during use.)
Clock Output: Positive edge at typically T0 -12 ns is +1.0 V into 50Ω, >2.0 V into Hi-Z.
Jitter: <0.1% of setting ±25ps. Applicable to pulse repetition period, delay and width parameters.
Signal Connectors: Pulse outputs are SMA; all others are BNC.
Power: 100V/120V ±10%, 60Hz; 200V/240V ±10%, 50 Hz; 350W Max.
Operating Temp: 0° to +50°C (Accuracy specifications apply at 20°C. Apply de-rating factor of 0.05%/°C to period, Vhi, Vlo. Add 0.1%/°C to width and delay).
Storage Temp: -40° to +70°C.
Dimensions: 22.3 cm (8.75 in.) high, 43.2 cm (17.0 in.) wide, 58.4 cm (23.0 in.) deep.
Weight
Chassis: (With front panel and no outputs) 34 kg (75 lb) net.
Output Channel: 1.6 kg (3.5 lb) net.
Shipping: (With 4 Channels) 50 kg (110 lb).

OPTIONS

P2002FE: 2V Fixed Edge Output Channel Module with extended width and delay ranges.
P2005: 5V Variable Transition Output Channel Module
P2005E: P2005 with extended width and delay ranges.
P2005FE: 5V Fixed Edge Output Channel Module with extended width and delay ranges
P2010: 10V Variable Transition Output Channel Module
P2010E: P2010 with extended width and delay ranges.

ACCESSORIES

350-31273: Rack Mount Slides.
350-31092: Rack Mount Ears.

Table 1-1. Available Pulse Voltages (All Specifications Are in Volts)

Output Channel Module	Pulse Amplitude ΔV	Available Range for V_{HI}
P2005, P2005E	2.501 to 5.000 1.251 to 2.500 0.626 to 1.250 0.313 to 0.625	–5.00 to 10.00 –2.50 to 5.00 –1.25 to 2.50 –0.625 to 1.25
P2010, P2010E	5.001 to 10.00 2.501 to 5.00 1.251 to 2.50 0.625 to 1.25	–5.00 to 15.00 –2.50 to 7.50 –1.25 to 3.75 –0.625 to 1.87
P2002FE	0.301 to 3.00 [1]	–3.000 to 4.000
P2005FE	0.500 to 5.00 [2] 0.250 to 2.50 [3] 0.125 to 1.250 [4] 0.0625 to 0.625 [5]	–5.00 to 10.00 –2.50 to 5.00 –1.25 to 2.50 –0.625 to 1.25

Waveform specifications apply to:

[1] *1.000 to 2.000*
[2] *2.501 to 5.000*
[3] *1.251 to 2.500*
[4] *0.626 to 1.250*
[5] *0.313 to 0.625*

Table 1-2. Output Channel Module Specifications

	VARIABLE EDGE [4]		FIXED EDGE [4]	
	5V P2005, P2005E [3]	10V P2010, P2010E [3]	2V P2002FE [3]	5V P2005FE [3]
PULSE REPETITION				
Period Frequency Program Accuracy	5 ns to 1s 1 Hz to 200 MHz ±2% of setting			
PULSE WIDTH [1]				
Range Extended Range [3]	2 ns to 26 µs 2 ns to 1s	4 ns (2.5 typ.) to 26 µs 4 ns (2.5 typ.) to 1s	2 ns to 1s	
Program Accuracy	±2% ±1 ns (<26 µs) ±5 (≥26 µs)			
TRANSITION TIMES	<1 ns to 2 µs at 5V (10 to 90% of ampl.)	<2 ns to 2 µs at 10V (10 to 90% of ampl.)	<320 ps, 1 to 2V (20 to 80% of ampl.)	<550 ps, 2.5 to 5.0V (10 to 90% of ampl.)
Program Accuracy	±2% ±1 ns		Not applicable	
PULSE DELAY [1]				
Range Extended Range [3]	2 ns to 26 µs 2 ns to 1s			
Program Accuracy [2] Referenced to T_0	±2% ±1 ns (<26 µs) ±5% (≥26 µs)			
DOUBLE PULSE MODE SPACING	>5 ns or 2x width (Pulse period >10 ns)	>10 ns or 2x width (Pulse period >20 ns)	>5 ns or 2x width (Pulse period >10 ns)	
PULSE LEVEL Program Accuracy	±2% of Vp-p ±25 mV	±2% of Vp-p ±50 mV	±2% of Vp-p ±15 mV	±2% of Vp-p ±25 mV
WAVEFORM DISTORTION	±5% ±175 mV	±5% ±350 mV	±10% ±100 mV	±5% ±175 mV
RAMP LINEARITY [2]	±5% of pulse amplitude		Not applicable	

[1] *Delay and width parameters are not calibrated beyond >50% of period. Duty cycles approaching 100% may be implemented using Inverted Pulse mode. Add a constant delay of 4.5 ns to delay specifications for chassis with mixed variable and fixed-edge modules.*

[2] *For transition times ≥10 ns.*

[3] *Extended width and delay module specifications (P2005E, P2010E, P2002FE and P2005FE).*

[4] *All timing specifications apply only at full amplitude and fastest rise/fall times.*

SECTION 2
INITIAL PREPARATION

2.1 RECEIVING INSPECTION

Check the shipment at the time of delivery for missing boxes and inspect each box for damage. Describe any box damage and list any shortages on the delivery invoice.

2.2 UNPACKING

1. **Unpack the boxes.** Unpack the boxes in a clean and dry environment. Save all the packing materials in case the instrument(s) have to be returned for repair.
2. **Inspect the equipment for damage.** Inspect the equipment carefully for any signs of mechanical damage regardless of the condition of the shipping boxes.
3. **If necessary, file a damage claim.** In the case of mechanical damage, call the shipper immediately and start the claim process.
4. **Call Wavetek.** Call Wavetek's Customer Service Department (619-279-2200) to inform them that the shipment arrived damaged. Please be prepared to provide a detailed damage report.

2.3 RETURNING EQUIPMENT

Follow these steps when you return equipment to Wavetek:

1. **Save the packing material.** Always return equipment in its original packing material and boxes. If you use inadequate material, you'll have to pay to repair any shipping damage as carriers won't pay claims on incorrectly packed equipment.
2. **Call Wavetek Customer Service and ask for a return authorization.** Wavetek's Customer Service representative (619-279-2200) will ask for your name, telephone number, company name, equipment type, and a description of the problem.
3. **Pack and ship the equipment.**

2.4 STORED EQUIPMENT

The instrument can be stored or shipped at temperatures between 20°C and 70°C. It should be protected against conditions which cause condensation within the instrument.

CAUTION

A unit placed in storage for six months or more should be connected to a variac and with instrument power on, the line voltage should be gradually increased from 0V to the specified operating voltage.

2.5 RACK MOUNTING

When rack mounting the unit with other equipment, be sure that warm air exhaust from another instrument is not being drawn into the instrument's rear panel air cooling intake. The unit should be supported along its length by either rack rails or rack slides. Option 350-31273 may be ordered from Wavetek to provide rack slides. Do not mount the unit by the front panel alone.

2.6 ELECTRICAL INSTALLATION

NOTE

Breaking the quality assurance seal may void your warranty.

2.6.1 Voltage Conversion

The instrument can operate with 100, 120, 200 or 240 Vac (±10%), 50 to 60 Hz. It is equipped with a fused voltage selecting connector.

To convert the instrument to another voltage (figure 2-1):

1. Remove power cord from the connector.
2. Slide cover door of the connector to the left.
3. Pull FUSE PULL tab out and to the left. The fuse will be pushed out and should be removed.
4. Remove the PC board.
5. Select operating voltage by orienting the PC board such that the value of the desired voltage is positioned on the top left of the board. The voltage values printed on the PC board are 100, 120, 200 and 240.
6. Push board firmly into the slot.
7. Push FUSE PULL tab to the right (back to normal position). The value of the operating voltage can now be seen and verified.

8. Insert proper fuse into holders (see chart below).

Voltage	SB Fuse
100	5 amp
120	5 amp
200	2.5 amp
240	2.5 amp

9. Slide cover door to the right.

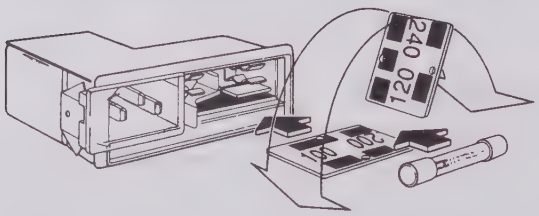


Figure 2-1. Voltage Selector and Fuse Replacement

2.6.2 Extension Cord Usage

In accordance with international safety standards, the unit is equipped with a three-wire power cable. When connected to an appropriate ac receptacle, this cable grounds the instrument cabinet. The protective action of the plug must not be negated by use of an extension cord without a protective conductor.

2.6.3 Signal Connections And Terminations

Because the output signal contains frequency components greater than 1 GHz on the fastest rise and fall time ranges, it is important to provide proper signal terminations. If any of the connectors, cables or attenuators used do not have flat responses beyond 1 GHz, degradation of pulse rise time will result.

The instrument output is backmatched to minimize pulse distortion due to mismatched loads and therefore should be terminated into 50Ω at all times. Use only high quality 50Ω terminations.

2.6.4 Rear Panel Connections And Controls (Refer to figure 2-2).

A description of each of the items located on the rear panel shown in figure 2-2 is given below.

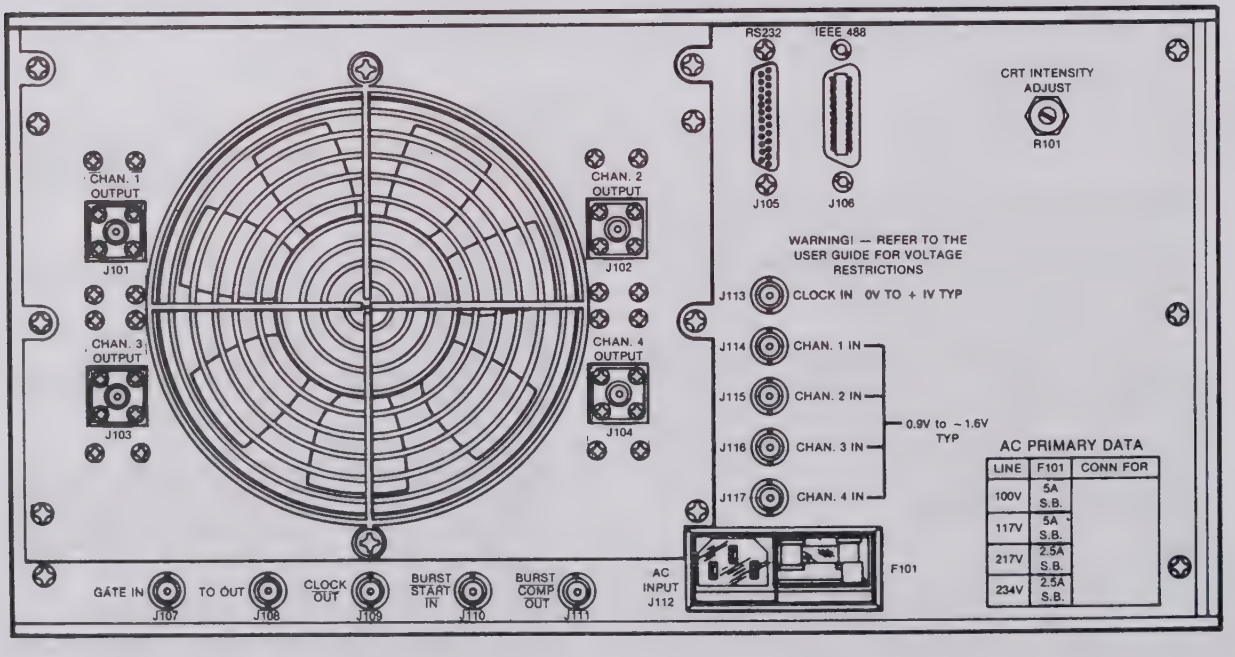


Figure 2-2. Model 2000 Rear Panel

J101 CHAN. 1 OUTPUT. Female SMA connector providing the output for Channel 1.

J102 CHAN. 2 OUTPUT. Female SMA connector providing the output for Channel 2.

J103 CHAN. 3 OUTPUT. Female SMA connector providing the output for Channel 3.

J104 CHAN. 4 OUTPUT. Female SMA connector providing the output for Channel 4.

J105 RS 232. 25 pin female "D" connector (DM 258). Provides interface between the instrument and external RS-232-C compatible equipment. See figure 2-3.

J106 IEEE-488. 24 pin female microribbon (57 series) connector for interface with IEEE-488 compatible equipment. See table 2-1.

J107 GATE IN. Plugged, not applicable.

J108 TO OUT. BNC connector for the output of the internal trigger signal.

J109 CLOCK OUT. BNC connector for the output of the internal clock signal.

J110 BURST START IN. BNC connector for the input of an external TTL level burst start signal.

J111 BURST COMP OUT. BNC connector for the output of the burst complete signal.

J112 AC INPUT. A plug for the line voltage input cable. (Refer to paragraph 2.6.1 for the procedure to change voltage configuration.)

J113 CLOCK IN. BNC connector for the input of an external TTL level drive clock signal.

J114 CHAN. 1 IN. BNC input connector for external ECL level signal to drive channel (independent of signal from the internal clock board).

J115 CHAN. 2 IN. (See J114 above.)

J116 CHAN. 3 IN. (See J114 above.)

J117 CHAN. 4 IN. (See J114 above.)

F101 AC FUSE. Designates the fuse in the voltage selecting and fused connector.

R101 CRT INTENSITY ADJUST. Control for adjusting the intensity of the CRT display.

PIN	SIGNAL NAME
1	PROTECTIVE GROUND
2	TRANSMITTED DATA
3	RECEIVED DATA
4	REQUEST TO SEND
5	CLEAR TO SEND
6	DATA SET READY
7	SIGNAL GROUND
8	RECEIVED LINE SIGNAL DETECTOR
20	DATA TERMINAL READY

NOTE
All other pins are open.

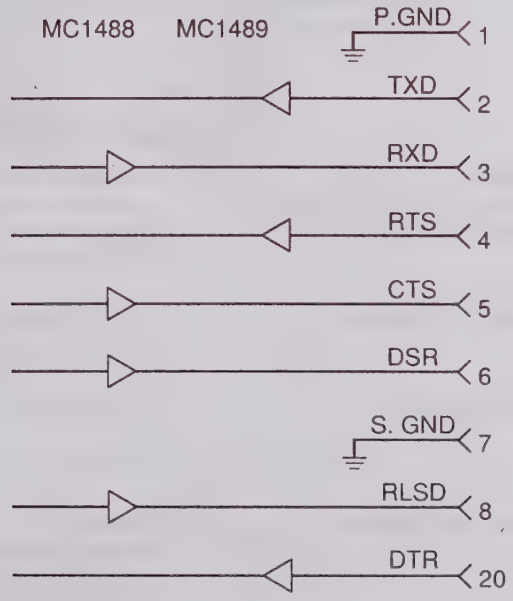


Figure 2-3. RS-232-C Interface Connector (J105) (Wired for DCE Operation)

Table 2-1. IEEE-488 Interface Connector (J106)

PIN	IEEE-488 MNEMONIC	SIGNAL NAME
1	DIO1	DATA INPUT/OUTPUT BIT 1
2	DIO2	DATA INPUT/OUTPUT BIT 2
3	DIO3	DATA INPUT/OUTPUT BIT 3
4	DIO4	DATA INPUT/OUTPUT BIT 4
5	EOI	END OR IDENTIFY
6	DAV	DATA VALID
7	NRFD	NOT READY FOR DATA
8	NDAC	NOT DATA ACCEPTED
9	IFC	INTERFACE CLEAR
10	SRQ	SERVICE REQUEST
11	ATN	ATTENTION
12	SHIELD	OVERALL CABLE SHIELD
13	DIO5	DATA INPUT/OUTPUT BIT 5
14	DIO6	DATA INPUT/OUTPUT BIT 6
15	DIO7	DATA INPUT/OUTPUT BIT 7
16	DIO8	DATA INPUT/OUTPUT BIT 8
17	REN	REMOTE ENABLE
18	GND	SIGNAL GROUND FOR DAV
19	GND	SIGNAL GROUND FOR NRFD
20	GND	SIGNAL GROUND FOR NDAC
21	GND	SIGNAL GROUND FOR IFC
22	GND	SIGNAL GROUND FOR SRQ
23	GND	SIGNAL GROUND FOR ATN
24	GND	LOGIC GROUND

NOTE
All signals are low true and conform to the IEEE-488-1978 standard.

2.7 INITIAL CHECKOUT

The following procedure checks functional capability and can be used for incoming inspection.

Modules are placed inside the instrument in a specific order. Before testing, identify the location of the options installed (paragraph 1.3) and perform the proper test for that option.

2.7.1 Test Equipment Required

Table 2-2 lists the test equipment and the minimum equipment specifications required to perform the initial checkout procedure. The performance and accuracy requirements of the test equipment should be 3 to 10 times better than the equipment under test. Substitution of any test equipment in this list is acceptable, provided it meets and/or exceeds this accuracy requirement.

Table 2-2. Test Equipment

Instrument	Suggested Model	Comments
Digital Voltmeter	Datron Model 1062 or H-P Model 3468A	>4 digits accuracy in dc volts
Frequency Counter	Racal/Dana Model 1994 or H-P Model 5385A	Frequency to 1GHz
Pulse Generator	Wavetek Model 137A	Capable of generating ECL and TTL levels with 50% duty cycle, Pulse repetition rate of 50 MHz or greater
Waveform Analyzer	Wavetek 1060 with 961 Probe or Wavetek 3000 with 3010 Probe	Bandwidth ≥1 GHz, 350 ps rise/fall time, Timing accuracy 1% of full scale, <20 ps jitter, Voltage accuracy 2% of full scale

Table 2-2. Test Equipment (Continued)

Instrument	Suggested Model	Comments
Oscilloscope		
Mainframe	Any Tektronix 7000 series. (Substitutions must meet or exceed bandwidth spec.)	Bandwidth ≥250 MHz.
Plug-ins		
Sampling Sweep Unit	Tektronix 7T11A	
Sampling Unit	Tektronix 7S11 (Qty 2)	
Sampling Head	Tektronix S-6	30 ps rise time, <±7% aberrations
Sampling Head Extender	Tektronix 012-0124-00 -or- Tektronix 012-0125-00	
50Ω Terminator	Tektronix 015-1022-00	
50Ω 6dB Attenuator		3W
50Ω 20dB Attenuator		≥15W
50Ω X 10 Attenuator	Tektronix 011-0059-02	
SMA Female to Female Adapter	Tektronix 015-1012-00	
SMA 50Ω Rigid Cables (Qty 2)		Bandwidth >5 GHz, Length 1 to 1.5 feet

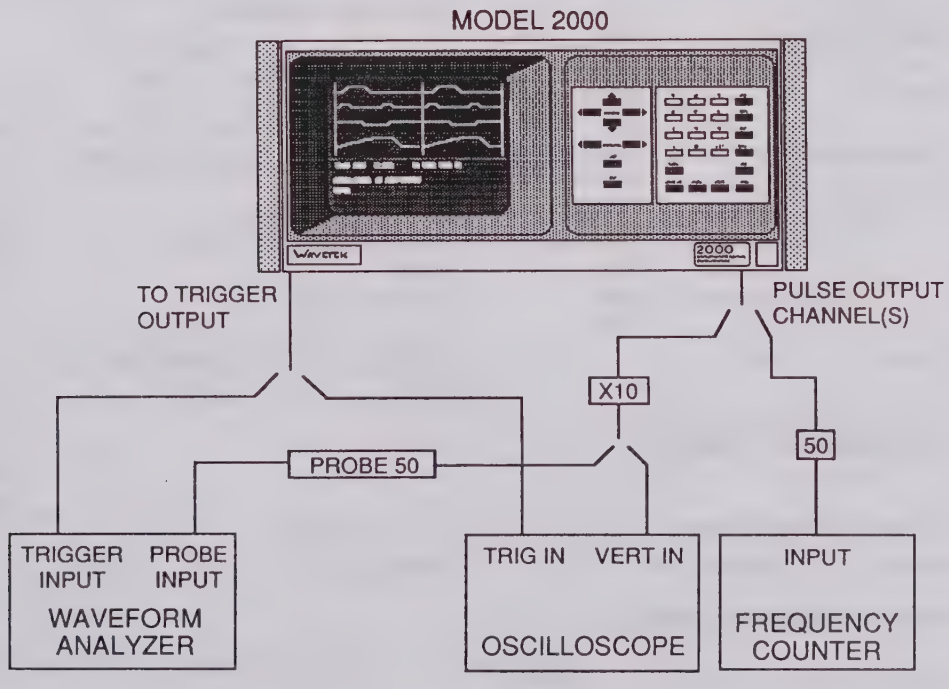


Figure 2-4. Model 2000 Verification Setup

2.7.2 Functional Check

1. Connect the Models 2000 and waveform analyzer as shown in figure 2-4. **All outputs of the Model 2000 (except T0) should be terminated into 50Ω.**

   CAUTION

   Care should be taken to insure that each pulse channel output is terminated with a 50 ohm load at any time ac power is present.

2. Turn both units on and allow the waveform analyzer to warmup for a few minutes. The Model 2000 does not need a warmup period, but none of the outputs are active until it has completed its selftest routine.

3. When the Model 2000 is shipped from the factory, each channel has been set to a standard turn-on program setting. Verify the settings on the unit with the listing below. To change the settings, position the cursor over the value you wish to change, enter the new value and press one of the terminator keys.

   Example: to set the period to 100 nanoseconds (ns) press the "1", "0", "0", and "NANO" keys.

4. Verify the following Model 2000 settings:

External CLK Trigger	OFF
Channel Clock EXT triggers	OFF
Burst	OFF
Internal Period	100ns

5. Verify the following settings for each channel:

Delay	10.00ns
Width	10.00ns
Vlow	0.0V
Inv	OFF
Dbl	OFF
Protection Level	1
Setup	00

Setting for 2002FE Module

Vhi	2.0V

Setting for 2005FE Module

Vhi	5.0V

Settings for 2005/2005E Modules

Lead	0.9ns
Trail	0.9ns
Vhi	5.0V

Settings for 2010/2010E Modules

Lead	1.8ns
Trail	1.8ns
Vhi	10.0V

6. Adjust the oscilloscope to display a full cycle of the waveform.

7. Measure the pulse period. The period should be approximately 100 ns.

8. Measure the pulse width. The pulse width should be approximately 10 ns.

9. Measure the amplitude (Vhi-Vlow). Verify that the amplitude approximately equals the Vhi setting for each module.

10. Align the leading edge of the pulse with one of the graticule lines on the oscilloscope (timebase set to 5ns/Div). Measure the delay. Change the Delay setting to 20ns. Change in delay should measure approximately 10ns.

11. Repeat steps 6 through 10 for each additional channel.

2.7.3 Operational Check

2.7.3.1 Initial Setup

All outputs of the instrument should be terminated into 50Ω. Modify the settings as follows:

External CLK Trigger	OFF
Channel Clock EXT Triggers	OFF
Burst	OFF
Internal Period	10.000ns

Set each channel as shown below:

Delay	2.000 ns
Width	4.000 ns
Vlow	0.000V
Inv	OFF
Dbl	OFF
Protection Level	1
Setup	00

Setting for 2002FE Module

Vhi	2.0V

Setting for 2005FE Module

Vhi	5.0V

Settings for 2005/2005E Modules

Lead	0.9ns
Trail	0.9ns
Vhi	5.0V

Settings for 2010/2010E Modules

Lead	1.8ns
Trail	1.8ns
Vhi	10.0V

2.7.3.2 Clock Check

1. Connect the Model 2000 and the frequency counter as shown in figure 2-4.

2. Measure the pulse period. The period should be approxmately 10 ns.

3. For the values listed in the following column, verify the pulse generator period readings are approximately equal to the settings.

Internal Period
1µs
1ms

4. Modify the Model 2000 settings as follows:

Count	00010
Burst	ON
Internal Period	100ns
Width	50ns

5. Move the cursor to the right of "Start?". To initiate a burst depress the "ENTER" key. Verify with the counter that the Model 2000 puts out a burst of 10 pulses.

2.7.3.3 Width Check

1. Modify the Model 2000 settings to those given in paragraph 2.7.2.

2. Modify the Model 2000 settings as follows:

Internal Period	500ns
Width	15ns

3. Use the waveform analyzer and oscilloscope to measure the pulse width. The pulse width should be approximately 15ns.

4. For the values listed in the following column, verify the pulse generator width readings are approximately equal to the settings.

Width Setting
30ns
200ns

5. Change the Model 2000 Internal Period setting to 100.0µs and the width setting to 5 µs.

6. Verify the width reading is approximately 5µs.

2.7.3.4 Delay Check

Note that there is a minimum delay in protection level 1 of 2ns ± 1ns with respect to T0. The delay to the first pulse in the double pulse mode is 0ns ± 1ns.

1. Match the instrument settings to those given in paragraph 2.7.2.

2. Change the Internal Period setting to 500.0ns.

3. Use the waveform analyzer and oscilloscope to measure the delay from T0 to the 50% point of the leading edge of the pulse. The delay should be approximately 10ns.

4. For the values listed in the following column, verify the pulse generator delay readings are approximately equal to the settings.

DELAY SETTING
30ns
200ns

5. Modify the Model 2000 settings as folllows:

Internal Period	100.0µs
Width	100.0ns
Delay	2µs

6. Verify the delay reading is approximately 2µs.

2.7.3.5 Leading/Trailing Edge Check

1. Match the instrument settings to those given in paragraph 2.7.2.

2. Modify the settings as follows:

Delay	5.000ns
Width	50.00ns
Lead/Trail	0.876ps

3. Use the waveform analyzer and oscilloscope with S-6 sampling head and 50Ω terminator to measure the edges. Measurements for the 2002FE module are 20% to 80%. All other measurements are 10% to 90%.

Module	Max. Rise/Fall Times
2002FE	320ps
2005	1ns
2005E	1ns
2005FE	550ps
2010	2ns
2010E	2ns

2.7.3.6 Amplitude Check

1. Match the Model 2000 settings to those given in paragraph 2.7.2.

2. Modify the settings as follows:

Internal Period	10.00µs
Width	50.00ns

3. Use the waveform analyzer and oscilloscope to measure the pulse amplitude for the 2002FE Module.

Vhi Setting (Vlow 0V)
2.0V
1.5V
1.0V

4. Use the waveform analyzer and oscilloscope to measure the pulse amplitude for the 2005, 2005E and 2005FE Modules.

Vhi SETTING (Vlow 0V)
5.0V
2.5V

5. Use the waveform analyzer and oscilloscope to measure the pulse amplitude for the 2010 and 2010E Modules.

Vhi SETTING (Vlow 0V)
10V
5.0V

2.7.3.7 Double Pulse Spacing Check

1. Match the Model 2000 settings to those given in paragraph 2.7.2.

2. Modify the settings as follows:

Internal Period	20.00ns
Delay	5.000ns
Width	2.000ns
Dbl	ON

3. Use the waveform analyzer and oscilloscope to display the pulses. Verify the presence of two complete pulses.

SECTION 3
OPERATION

3.1 PULSE PARAMETER DEFINITIONS

The instrument provides full control of the pulse amplitude, delay, period, width and rise and fall times. The pulses can be single or double, normal or inverted, and can be programmed for a specified number of pulses per burst. The following definitions explain what is meant by each parameter.

Period. Pulse period is the time between successive cycles of a pulse train. Refer to figure 3-1. Range is 5 to 10 ns (other settings by divider).

NOTE

Delay and width definitions apply only with rise and fall times set to minimum.

Delay. Pulse delay is the time between the leading edge of the trigger output and the 50% amplitude point on the leading edge of the output pulse (transition time set to minimum). Refer to figure 3-2 and table 3-1.

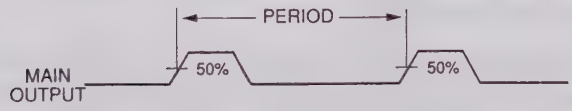


Figure 3-1. Period Waveform

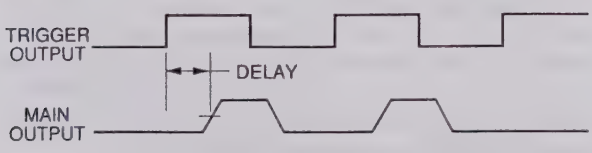


Figure 3-2. Delay Waveform

Table 3-1. Delay and Width Ranges

Range Number	Range Values
0	2 ns to 16.00 ns
1	16.10 ns to 128.0 ns
2	128.1 ns to 2.048 ns
3	2.100 µs to 32.00 µs
4	33 µs to 350.0 ms
5	351 µs to 5.000 ms
6	5.100 ms to 85.00 ms
7	85.10 ms to 1s

Width. Pulse width is the time between the 50% amplitude points on the leading and trailing edges of a pulse. Refer to figure 3-3 and table 3-1. This is valid at the fastest ramp setting only. Other settings of the leading and trailing edges may require an adjustment of the width setting to achieve the desired results.

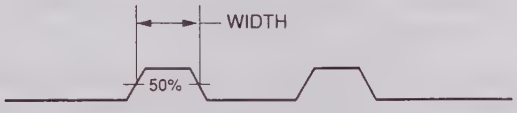


Figure 3-3. Width Waveform

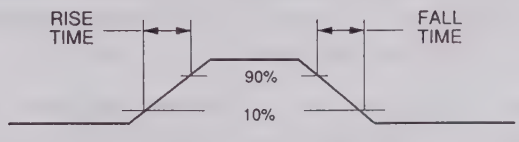


Figure 3-4. Rise/Fall Time Waveform

Figure 3-5. Double Pulse Waveform

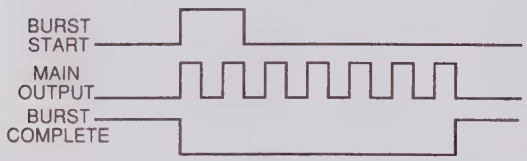


Figure 3-6. Burst Waveform

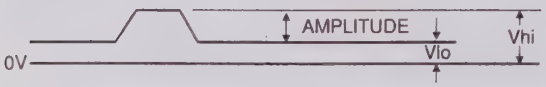


Figure 3.7. Amplitude, Vhi, and Vlo Waveform

Rise Time. The rise time is the time from the 10% to 90% (20% to 80% for 2002FE) amplitude points on the pulse leading edge. Refer to figure 3-4 and table 3-2.

Fall Time. The fall time is the time from the 90% to 10% (80% to 20% for 2002FE) amplitude points on the pulse trailing edge. Refer to figure 3-4 and table 3-2.

Double Pulse. Pairs of identical pulses within a given period are generated where the first pulse is coincident with the trigger output, and the second pulse begins after the programmed delay. Refer to figure 3-5.

Burst. A burst of pulses up to 65,535 (depending on period and frequency range settings) may be programmed to begin on one of several events. When the specified number of pulses have been output, the pulse train stops until the next burst is triggered. After the burst count is reset to a new value, the first trigger to the Model 2000 may not generate a burst with the correct number of counts. Refer to figure 3-6.

Table 3-2. Leading & Trailing Edge Ranges

Range Number	Range Values
2005 and 2005F Modules	
0	875 ps to 14.0 ns
1	14.1 ns to 220 µs
2	221 µs to 5 µs
2010 and 2010F Modules	
0	1.6 ns to 18 ns
1	18.1 ns to 400 µs
2	401 µs to 5 µs

Amplitude. Pulse amplitude is the difference between the high voltage (Vhi) and the low voltage (Vlo) levels. Vhi is always more positive than Vlo. Refer to figure 3-7.

3.1.1 VHi — VLo Ranges

Figures 3-8 through 3-12 show the range boundaries for each programmed amplitude.

Variable Transition Drivers. The unattenuated output voltage swing (Vs VHi — VLo) range of the instrument is 2.5V to 5V for a 5V channel and 5V to 10V for a 10V channel. Smaller voltage swings are achieved by using attenuators in the x2, x4, and x8 ranges. There are limitations on the minimum Vs settings using this method (see figures 3-8 and 3-9).

Fixed Transition Drivers. A small pulse amplitude with large offset is allowed, though some degradation of the waveform quality may be seen (see table 1-1 and figures 3-10 and 3-11). Note that for the 5005FE module, this includes the x2, x4 and x8 attenuators.

3.2 POWER-ON STATE

The state in which the instrument comes up after application of power is determined by the values stored in EEPROM. It is therefore up to the user to specify the desired state by saving the appropriate values to EEPROM. This is accomplished either through the Menu for manual operation, or through a series of commands over one of the remote interfaces. The following events occur during the power-on initialization:

1. A System Test is executed.
2. Setups 0 through 4 are loaded from EEPROM.

3. All Interface Parameters are loaded from EEPROM.
4. All Deskewing Constants are loaded from EEPROM.
5. The Protect level is set to 1.
6. Setup number 0 becomes the active setup.
7. The CRT shows the Main Operating Display.

3.3 FRONT PANEL OPERATION

This section describes how to operate the instrument through its optional front panel.

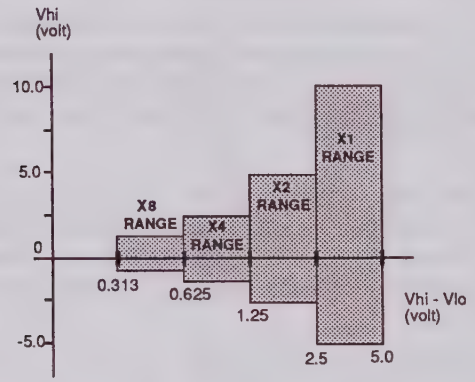


Figure 3-8. Models 2005 and 2005E Allowable Voltage Range

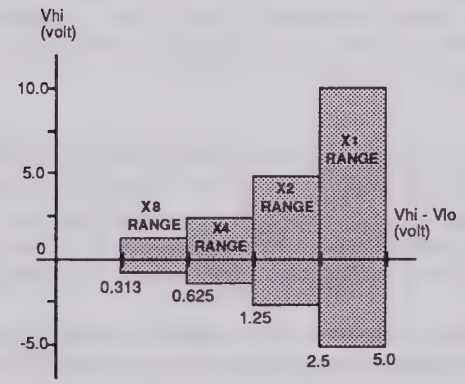


Figure 3-9. Model 2010 and 2010E Allowable Voltage Range

3.3.1 CRT Display

The following descriptions refer to the display screen.

External CLK Trigger. If OFF, the clock is supplied internally. If ON, the clock is supplied by an external source through J113. Under certain conditions, there may be a problem with jitter using internal trigger. Improved jitter specifications may be obtained by connecting an external signal source to J113.

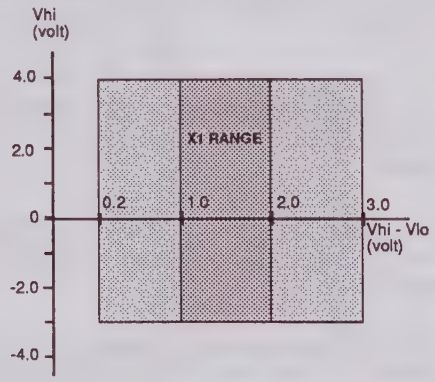


Figure 3-10. Model 2002FE Allowable Voltage Range

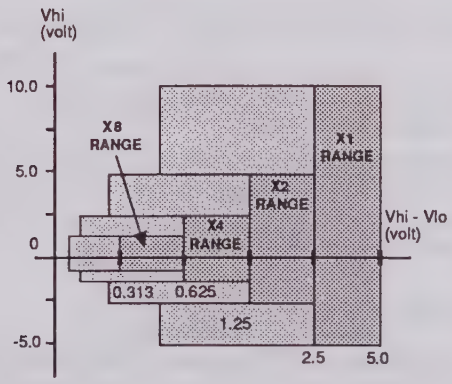


Figure 3-11. Model 2005FE Allowable Voltage Range

For figures 3-8 through 3-11

Waveform Specifications Applied

Waveform Specifications Not Applied

EXT—ON/OFF. Channel triggering status. OFF is internal. ON is external. The external inputs are J114 through J117, J109 is CLK out.

Internal Period. The period of the internal clock.

Burst. If ON, the unit is in the Burst mode. The burst will not start however, unless externally triggered, or the ENTER button is pressed when the cursor is on the Start parameter. After the burst count is reset to a new value, the first trigger to the Model 2000 may not generate a burst with the correct number of counts. If OFF, the Burst mode is disabled.

Count. The number of cycles that will be completed during a burst if the Burst mode is ON. There can be 1 through 65,535 cycles (maximum count depends on the period range).

Start?. Used when the Burst mode is ON. To begin the burst, the ENTER button is pressed when the cursor is on the question mark.

Ch. The channel number as corresponds to the channel board and output driver module in the positions 1, 2, 3 or 4. The positions are marked on the frame inside the unit.

Delay. The delay from the trigger output signal to the beginning of the pulse. See section 1 for specifications regarding the measurement of the true delay.

Width. The time for the width of the pulse.

Lead. The time for the leading edge of the pulse ("FIXED" displayed on screen for fixed edge modules).

Trail. The time for the trailing edge of the pulse ("FIXED" displayed on screen for fixed edge modules).

Vhi. The high voltage value for the pulse.

Vlow. The low voltage value for the pulse.

Inv. Indicates whether a channel is in the Inverted mode. If ON, the baseline will be at Vhi and will go to Vlo for the duration of the pulse. If OFF, the baseline will be at Vlo and will go to Vhi for the duration of the pulse.

The output pulse may disappear when switching between Normal and Invert. The following procedure will prevent this from occurring:

1. Program the pulse width to 50% ±5% of the pulse period.
2. Invert the waveform.
3. Program the pulse width to the desired setting.

To restore a locked-up output:

1. Program the pulse width to 50% ±5% of the pulse period.
2. Program the pulse width to the desired setting.

Dbl. Indicates whether a channel is in the Double Pulse mode. If ON, two pulses will occur during one period. The first pulse will occur at T0 and the second at the programmed delay time. If OFF, only one pulse will occur during a period.

Protection Level. Designates the level of protection offered in the case of programmed values that are out of specification. Three protection levels (PL 1, PL 2 and PL 3) are available. The system comes up in the first protect level (PL 1).

CAUTION

It is recommended that PL 1 be used at all times. In PL 2 and PL 3, the operating specifications of the unit may be exceeded. To guard against this possibility, the output signal should be checked to verify that requirements are being met. Possible damage to external hardware may also occur.

PL 1 is the highest degree of protection. Any error made while programming the pulse parameters will show up as an inverted display, i.e. highlighted, or a sentence or phrase describing what is wrong. No change in the output of the unit will occur until the value is corrected.

PL 2 will show an error but the unit will attempt to output a signal as close as possible to the programmed value.

PL 3 will not show an error and the unit will attempt to output the signal.

Setup. The number of the current setup (a set of all parameter values for four channels). There are forty setups available.

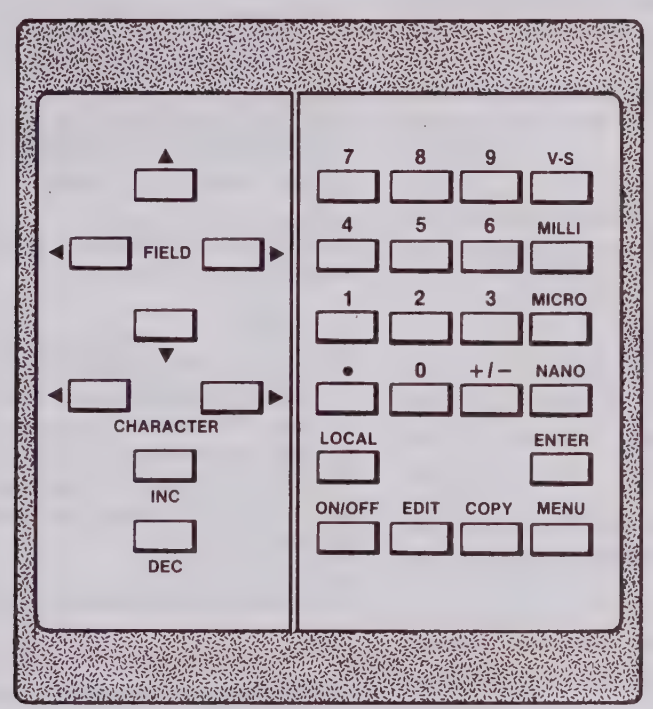
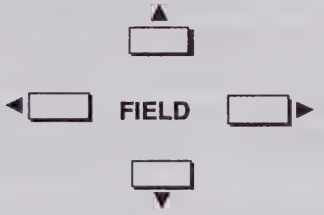


Figure 3-12. Model 2000 Keyboard

3.3.2 Keyboard

Refer to figure 3-12 for key locations.



NOTE

When the field keys are used, the number where the cursor was before the key was pressed is entered and the output will change if not in the Edit mode.

The ▲ key moves the cursor up one line and to the beginning of a parameter.

The ▼ key moves the cursor down one line and to the beginning of a parameter.

The ◄ key moves the cursor one parameter to the left.

The ► key moves the cursor one parameter to the right.

◄ **CHARACTER** ►

The ◄ key moves the cursor one space to the left.

The ► key moves the cursor one space to the right.

The INC. key increments by one the number where the cursor is.

INC.

The [ ] key decrements by one the number where the cursor is.

DEC

The [ ] keys change the value where the cursor is to the value above the button.

V-S

The [ ] key changes the parameter units to either volts or seconds depending on the cursor location, and enters the number to the left of the cursor.

MILLI

The [ ] key changes the parameter units to either millivolts or milliseconds, and enters the number to the left of the cursor.

MICRO

The [ ] key changes the parameter units to microseconds and enters the number to the left of the cursor.

NANO

The [ ] key changes the parameter units to nanoseconds and enters the number to the left of the cursor.

LOCAL

The [ ] key sets the operating mode to local.

In Local mode the parameters are controlled from the front panel.

In Remote mode the parameters are controlled from the IEEE-488 or RS-232-C interfaces. In this mode, the screen display shows only the word "REMOTE" and the keyboard is locked out. The Remote mode is entered by addressing the instrument over the IEEE-488 or RS-232-C interfaces.

ENTER

The [ ] key enters values into the registers and leaves the cursor at the beginning of the parameter.

It is also used to initiate a burst when in the Burst mode.

The ENTER key can be used to obtain a more detailed menu display. See paragraph 3.3.4 for an explanation of the menu.

ON/OFF

The [ ] key is used for toggling ON/OFF parameters.

EDIT

The [ ] key toggles in and out of the Edit mode. The words "EDIT MODE" appear at the bottom of the screen when in the Edit mode.

When in the Edit mode, changes are made on the screen but not the output. The output is modified when the user toggles out of the Edit mode.

When not in the Edit mode, changes are made on the screen and at the output.

COPY

The [ ] key toggles in and out of the Copy mode. The Copy mode allows copying of channel parameters from any channel of any setup to any channel of the currently active setup. This also includes copying from channel to channel within the currently active setup. The following line will appear near the bottom of the screen when in Copy mode.

COPY from Ch X, Setup XX to Ch X, Setup XX Execute?

Use the cursor control keys to move the cursor to each of the first three parameters and change to the desired values. To initiate the actual copy process, move the cursor to the "Execute?" position and press ENTER. Additional copies to different channels may be made before exiting the Copy mode.

MENU

The [ ] key brings up the menu display if pressed when the waveform display is on the screen.

It is also used for a less detailed menu when in one of the menu categories. See paragraph 3.3.4 for an explanation of the menu.

•

The [ ] key is used for entering a decimal point.

+/-

The [ ] key toggles between positive and negative signs.

3.3.3 Modifying Parameters

To modify a parameter, the cursor is moved to the field to be changed, and the value to be programmed is entered on a numeric keyboard or stepped by the increment/decrement keys. As each parameter is changed, the graphic display of the output waveforms will change accordingly.

3.3.4 Menu

When the instrument is powered on, it will display the pulse waveforms and parameters. A series of menus may be selected by pressing the MENU button which will allow the user to change other settings. Figure 3-14 shows a graphic representation of the menu relationships.

When the MENU button is pressed, the screen will display the following:

```
** EH-2000 MENU **
—Interface constants
—Channel Setup Storage
—T0 Deskew Constants
—Calibration history
—System test
—Special Functions

Place the cursor on selection and press ENTER. Use
the MENU key to return to previous display.
```

To obtain a more detailed display of a menu item, move the cursor to the item by using the up and down field keys, then press ENTER.

NOTE

The up and down field keys are used throughout the menu to move the cursor to the desired position.

3.3.4.1 Interface Constants

When this line is selected, it enables the user to select IEEE-488 or RS-232 interface constants. When the interface is selected, the screen will display the appropriate constants. For IEEE-488, the screen will display the following:

```
IEEE-488 Parameters

SPG address (0-30)                    >
Parallel poll bit (1-8, 0 = None)     >
Device clear set to power-up state    >
Save to EEPROM                        >

Place cursor on selection and use INC/DEC to
change. Use the MENU key to return to previous
display.
```

The values are input to the right of the arrows.

To save to the EEPROM, ENTER is pressed when the cursor is opposite "Save to EEPROM". If the values are not saved, they will only be in effect until the power is turned off.

When RS-232 is selected, the screen will display the following:

```
RS-232 Parameters

Baud rate                             >
Number of data bits (5,6,7,8)         >
Number of stop bits (1,1.5,2)         >
Parity (odd, even, none)              >
Save to EEPROM                        >

Place cursor on selection and use INC/DEC to
change. Use the MENU key to return to previous
display.

The values are input to the right of the arrows.
```

To save to the EEPROM, ENTER is pressed when the cursor is opposite "Save to EEPROM". If the values are not saved, they will only be in effect until the power is turned off.

3.3.4.2 Channel Setup Storage

When this line is selected, the screen will display the following:

```
Channel Setup Storage
Restore channel setups to power-up state  >
Save first five channel setups to EEPROM  >

NOTE:
Restoring channel setups affects only the first five
setups.

Only the first five channel setups may be saved to
EEPROM.

Place cursor on selection and press ENTER. Use the
MENU key to return to previous display
```

Values for these 5 setups are programmed initially at the factory. Copying the setups to permanent storage will erase the factory values and store whatever values are in the registers. Restoring the setups to the power up state brings the setups to the values last stored regardless of changes made to the front panel.

For storage of all 40 setups, values can be stored remotely through one of the interfaces and recovered at a later time.

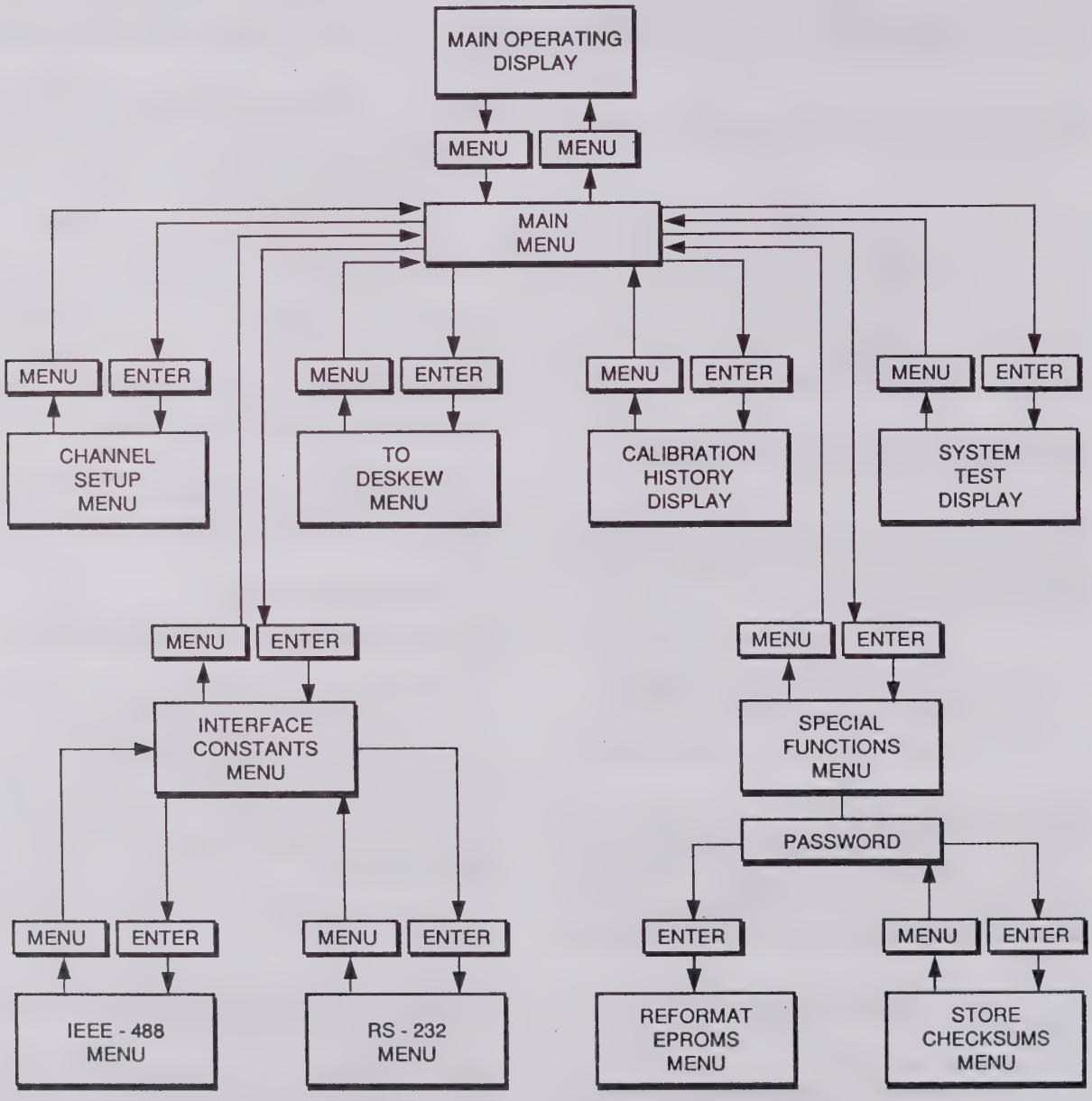


Figure 3-13. Menu Relationships

3.3.4.3 T0 Deskew Constants

When this line is selected, the screen will display the following:

```
T0 Deskewing Constants
Ch 1      > X.XXX S
Ch 2      > X.XXX S
Ch 3      > X.XXX S
Ch 4      > X.XXX S
Save to EEPROM
Use the MENU key to return to previous display.
```

Deskewing constants specify an additional set of values which offset each channel's output pulse from the common trigger output. These values correct for the offset caused primarily by test hardware such as varying cable lengths and fixture capacitance. Deskewing constants allow all channels to arrive at the desired points at the time indicated by the Delay parameters. Once the deskewing parameters have been entered, the operator is freed from having to consider the effects of hardware delays on his programming parameters. Note however, that the sum of the deskewing constant plus the programmed delay for any given channel may not exceed the instrument specifications.

The limits for the deskewing constants are 0 - 5 ns.

To save to the EEPROM, ENTER is pressed when the cursor is opposite "Save to EEPROM" If the values are not saved, they will only be in effect until the power is turned off.

3.3.4.4 Calibration History

When this line is selected, the screen will display the following:

```
                    Ser      Cal Date
    Clock Bd.       XXXX     MMDDYY
N V Channel 1       XXXX     MMDDYY
N V Channel 2       XXXX     MMDDYY
N V Channel 3       XXXX     MMDDYY
N V Channel 4       XXXX     MMDDYY

Use the menu key to return to previous display.
```

"N" will be the maximum voltage rating of the channel, ex. 5 V.

This history is stored in EEPROMs located on the clock and channel boards.

3.3.4.5 System Test

When this line is selected, the screen will display the following:

```
System Test — SPG vers X.X
ROM 0 Checksum                >
ROM 1 Checksum                >
ROM 2 Checksum                >
ROM 3 Checksum                >
Clock ROM Checksum            >
Channel 1 Checksum            >
Channel 2 Checksum            >
Channel 3 Checksum            >
Channel 4 Checksum            >
EEPROMS Checksum              >
System RAM 0                  >
System RAM 1                  >
System RAM 2                  >
System RAM 3                  >
Display RAM 0                 >
Display RAM 1                 >
CRT Controller                >
Clock Chain                   >
Timer                         >
Math Processor                >

Use the MENU key to return to previous display
```

The System Test is executed from the Menu at power-up, or from a command over one of the remote interfaces. A "PASS" or "FAIL" indication will follow each of the tests listed above.

The following is a brief description of each of the tests performed:

ROM 0 through ROM 3 Checksum. The sums of these four ROMs located on the CPU board are compared against the values stored in EEPROM.

Clock ROM Checksum. The checksum of the ROM located on the Clock Board is compared against the value stored in EEPROM. See note below.

Channel 1 through 4 Checksum. The checksum of the ROMs located on each of the channel boards are compared against the values stored in EEPROM. See note below.

EEPROMS Checksum. The checksum of the EEPROMs located on the CPU board are compared against the values stored in EEPROM. These values are updated each time the contents of the EEPROMs are changed.

System RAM 0 through 4. The four RAMs located on the CPU board are tested non-destructively.

Display RAM 0 and 1. The two RAMs located on the CRT Controller board are tested non-destructively.

CRT Controller. The CRT Controller is functionally tested.

Clock Chain. The Clock Chain is functionally tested.

Timer and Math Processor. The Math processor and Timer are functionally tested.

NOTE

If a Clock Board or a Channel Board is replaced, the checksum test for that board will fail because of its different calibration data. See paragraph 3.3.4.6 for the method of correcting this situation.

3.3.4.6 Special Functions

When this line is selected, the screen will display the following:

```
Please enter password:
Use the MENU key to return to the previous display
```

The password is available upon the request of an authorized representative for the company to which the unit is sold. It is intended to prevent tampering with the configuration of the unit except by those with need, i.e., cal lab, etc.

Pressing the ENTER key after the password is entered will give the following display:

```
Special Function

Save checksums to EEPROM          >
Reformat EEPROM                   >
Multiple Ext Clk: Toggle?         >

Place cursor on selection and press ENTER
Use the MENU key to return to the previous display
```

The following is a brief description of each function above:

Save checksums to EEPROM. The checksums of the clock board and all channel boards are stored in the EEPROM when the ENTER key is pressed. Checksums formerly in the EEPROM are erased. See paragraph 3.4.5.4 — SAVECS.

Reformat EEPROM. Erases and reformats the EEPROMs on the microprocessor board. The "Save checksums" routine must be performed after this function.

3.4 REMOTE OPERATION

This section describes each of the remote commands which may be sent to the instrument from either the IEEE-488 or the RS-232 interface. The same syntax is used with either interface.

3.4.1 Combining Commands

Individual commands may be grouped into complete messages by separating each command from the next with a semi-colon (;). This gives the system controller the ability to change all desired pulse parameters in a single output statement.

EXAMPLE: The message PER:100n;WID:35n,1; DLY:15n,1 (sent to channel 1) would set the period to 100 ns and would set the channel one output to a width of 35 ns after a delay of 15 ns.

3.4.2 Message Terminators

Each complete message sent to the instrument must be terminated in one of several ways to indicate the end of transmission. A line-feed character (ASCII code decimal 10 decimal) may be sent by either interface as a terminator. A carriage-return (ASCII code decimal 13) and line-feed sequence may also be used. In addition, the EOI (End Or Identify) line of the IEEE-488 interface may also be used as a message terminator.

All commands ending with a question mark (?) will cause the instrument to return a data message over the interface to the controller. All messages sent over the IEEE-488 interface from the instrument to the controller will be terminated by a single line-feed character coincident with the EOI line going true. Messages sent over the RS-232 interface from the instrument to the controller will be terminated by a carriage-return and line-feed sequence.

3.4.3 Error Reporting

The instrument scans all commands for errors before execution. Once a syntax error or missing argument error is detected, the remainder of the command is ignored. That is, only that part of the command up to the point error is executed. Parts of a command that are simply out of range or incompatible with other parameters do not cause the remainder of the command to be ignored. Regardless of the type of error detected, the instrument will report the error to the controller in one of two ways depending on which interface is being used.

3.4.3.1 RS-232

The instrument will send a message to the controller as soon as an error is detected. One of the following three messages will be sent:

Syntax Error. Sent whenever a non-valid command name is received.

Missing Argument. Sent when a required parameter is missing from the command.

Program Error. Sent whenever a parameter is out of its valid range.

All error messages will be terminated by a carriage-return and line-feed sequence.

3.4.3.2 IEEE-488 Interface

The instrument will indicate an error condition to the controller by the following three procedures. No actual message will be sent.

1. Upon detection of an error, the instrument will assert the Service Request (SRQ) line of the IEEE-488 interface. This line will stay active until either a Serial Poll is performed or until another valid command is sent and no more errors are present.

2. Detection of an error will cause the instrument to assert a previously selected bit during a Parallel Poll. A Parallel Poll is performed by sending the Parallel Poll Enable (PPE) message over the interface. The bit to be asserted is selected by the PPLBIT "n" command. If "n" is set to 0, then none of the bits are asserted, and therefore detection of an error is not possible using a Parallel Poll. The selected bit (if any) will stay active during subsequent Parallel Polls until either a Serial Poll is performed or until another valid command is sent and no more errors are present.

3. Detection of an error will cause the instrument to return a non-zero byte during a Serial Poll. A Serial Poll is performed by sending a Serial Poll Enable (SPE) message over the IEEE-488 interface. One of the following eleven decimal values will be sent depending on the type of error which occurred:

65 Syntax error

66 Missing argument error

67 Period out of range

68 Channel 1 parameters out of range: LED and TED edges on different ranges or VHI and VLO incompatible

69 Same as 68 except for Chan 2

70 Same as 68 except for Chan 3

71 Same as 68 except for Chan 3

72 Channel 1 parameters are incompatible with period

73 Same as 72 except for Chan 2

74 Same as 72 except for Chan 3

75 Same as 72 except for Chan 4

A Serial poll will reset the SRQ line of the IEEE-488 interface, clear the Parallel Poll response bit, and return the Serial Poll byte to the zero value. A valid command will also clear these same items provided that no remaining errors are present.

3.4.3.3 IEEE Function Subsets

The following IEEE-488 subsets are available on the instrument:

FUNCTION	SUBSET
Source Handshake Controls the initiation and termination of asynchronous multiline message transfers.	SH1
Acceptor Handshake Controls the transfer rate of asynchronous multiline messages.	AH1
Talker Sends device dependent data to other devices when addressed to talk.	T6

Listener Receives device dependent data from other devices when addressed to listen. L4

Service Request Requests service asynchronously from the controller in charge. SR1

Remote/Local The device communicates over the interface or with the front panel controls. RL1

Parallel Poll Capability to send a Parallel Poll Response message to the controller in charge without being previously addressed to talk. PP2

Device Clear Able to be cleared either individually or as part of a group of devices. DC1

Device Trigger Able to have its operation started individually or as part of a group of devices. DT1

NOTE

For additional information, refer to the IEEE Instrumentation and Measurements Group, "Standard Digital Interface for Programmable Instrumentation" Standard 488-1978: Institute of Electrical and Electronic Engineers, July 25, 1980.

3.4.4 Command Syntax

All command names sent to the instrument may be in either upper or lower case characters. Each command name must be separated from any following parameters by a colon (:) or a space.

The following conventions are used throughout the list of command names

[ ] indicates an optional parameter.

/ indicates a choice of one parameter.

c indicates an integer channel number from 1 through the number of channel cards currently installed.

n indicates an integer value within the valid range.

v indicates a floating point value within the valid range.

u indicates one of the following measurement units. Upper or lower case characters may be used.

p (picoseconds)
n (nanoseconds)
μ (microseconds)
m (milliseconds or millivolts)
(seconds or volts)

NOTE

No character is used to indicate seconds or volts since time or amplitude will be determined by the command name itself.

3.4.4.1 Commands Affecting All Channels

EXTTRIG:ON/OFF (Firmware Rev. 1.6 & above) Sets the external trigger either on or off. If OFF, the period of all channels will be set by the PER command. If ON, the period is determined by the signal input at the rear panel CLOCK IN connector J113 (J109 on earlier models).

EXAMPLES: EXTTRIG:ON
EXTTRIG:OFF

INTTRIG:ON/OFF (Firmware Rev. 1.5 & Below) Sets the internal trigger either on or off. If ON, the period of all channels will be set by the PER command. if OFF, the period is determined by the signal input at the rear panel CLOCK IN connector, J109.

PER:vu Sets the period of the internal clock to the desired time interval. The time defined by vu must be within the valid period range.

EXAMPLES: PER:123n
PER:.123u

BURSTCT:n Sets the number of pulses that will be output during each burst. 'n' may range from 1 through 65535. This command does not actually enable or initiate the burst itself.

EXAMPLES: BURSTCT:5
BURSTCT:12345

BURST:ON/OFF Enables or disables the Burst mode. Once BURST:ON has been sent, all subsequent BURSTGO commands will initiate a burst as defined by the BURSTCT command. No bursts will occur if BURST:OFF has been sent.

EXAMPLES: BURST:ON
BURST:OFF

BURSTGO Initiates a burst if Burst mode has been previously enabled by using the BURST ON command. The length of the burst must have been previously defined in a BURSTCT command. The IEEE-488 interface can also start a burst by sending the Group Execute Trigger

(GET) message. In addition, a signal to the rear panel BNC connector J109 (Burst Start) will also initiate a burst. After the burst count is reset to a new value, the first trigger to the Model 2000 may not generate a burst with the correct number of counts.

EXAMPLE: BURSTGO

3.4.4.2 Commands Affecting Only One Channel

CH:c Selects the default channel for all subsequent channel commands. Unless an optional channel parameter is added to these commands, the default channel as specified in this command will be used. The parameter 'c' may not exceed the number of channel boards installed in the unit. The instrument defaults to CH:1 at power up.

EXAMPLES: CH:1 and CH:4

CHTRIG:ON/OFF[,c] Selects the trigger source for the channel board given by the number 'c'. Internal source is selected with OFF. ON will select an external source at the corresponding rear panel CHAN IN connector, J114-J117. If no channel number is used, the default is to channel 1.

EXAMPLES: CHTRIG:ON, 1
CHTRIG:OFF,3

DLY:vu[,c] Sets the delay from the trigger output to the start of the pulse on the desired channel. In Double Pulse Mode, the DLY command sets the delay between the first and second pulse in each period. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: DLY:36n
DLY:40u,3

WID:vu[,c] Sets the pulse width of the desired channel. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: WID:10.5u
WID: .5m,1

LED:vu[,c] Sets the leading edge time of the pulse on the desired channel. Leading edge time is defined from 10% to 90% of pulse amplitude. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: LED:5u
LED:1500p,2

TED:vu[,c] Sets the trailing edge time of the pulse on the desired channel. Trailing edge time is defined from 90% to 10% of pulse amplitude. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: TED:12n and TED:5,U,4

VHI:vu[,c] Sets the voltage level of the output pulse during its active portion as defined by the WID command. The value defined by vu must be within the valid range defined for the particular model being programmed. The numerical value of VHI must always be greater than VLO. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: VHI:4
VHI:-123m,2

VLO:vu[,c] Sets the voltage level of the output pulse during its baseline or inactive portion. The value defined by vu must be within the valid range defined for the particular instrument being programmed. The numerical value of VLO must always be less than VHI. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: VLO:-2.6
VLO:100m,1

ZEROCHAN:[c] Used to set the channel (c) output to 0 volts.

DBL:ON/OFF[,c] Enables or disables the Double Pulse Mode on the desired channel. If OFF, only one pulse per period is output. If ON, two pulses of identical waveshape are output per period with the second pulse delayed from the first by the value defined in the DLY command. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: DBL:ON
DBL:OFF,3

INV:ON/OFF[,c] Enables or disables the Invert Mode on the desired channel. If OFF, the pulse baseline will be at VLO and the pulse will go to the VHI level for the time specified by WID. If ON, the pulse baseline will be at VHI and the pulse will go to the VLO level for the time specified by WID. Invert mode may be combined with Double Pulse Mode. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: INV:ON,2
INV:OFF

T0:vu[,c] Sets the deskewing delay from the trigger output to the start of the pulse for the desired channel. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: T0:2.5n
T0:3n,2

COPY:c1,n,c2 Copies channel 'c1' parameters from setup 'n' to channel 'c2' of the current setup.

EXAMPLES: COPY:3,27,1
COPY:2,10,2

3.4.5.3 Interface Control Commands

PPLBIT:n Sets the active Parallel Poll bit on the IEEE-488 Bus. This bit (1-8) will be asserted in response to a Parallel Poll Enable command from the System Controller only if the instrument has requested service by way of the SRQ line. If 'n' is set to 0, then none of the bits will be set.

EXAMPLES: PPLBIT:1
PPLBIT:8

DEVICE:n Sets the IEEE-488 device address. 'n' may range from 0 through 30.

EXAMPLES: DEVICE: 5
DEVICE: 30

PONCLR:ON/OFF Sets the response of the instrument to the IEEE-488 Device Clear (DCL) and Selected Device Clear (SDC) messages. If set to ON, the instrument will include restoration of the first five setups to the power-on state as part of its clearing function. If set to OFF, the first five setups will not be restored to the power-on state.

EXAMPLE: PONCLR:ON
PONCLR:OFF

SAVE488 Saves all IEEE-488 parameters to EEPROM.

EXAMPLE: SAVE488

BAUD:n Sets the baud rate of the RS-232 interface. The following numbers are valid values for "n": 110, 300, 1200, 2400, 4800, 9600, and 19200.

EXAMPLES: BAUD:300
BAUD:9600

DATA:n Sets the number of data bits used on the RS-232 interface. The value "n" must be 5, 6, 7, or 8.

EXAMPLES: DATA:7
DATA:5

STOP:n Sets the number of stop bits used on the RS-232 interface. The value n must be 1, 1.5, or 2.

EXAMPLES: STOP:1
STOP:2

PARITY:ODD/EVEN/NONE Sets the type of parity used on the RS-232 interface.

EXAMPLES: PARITY:ODD
PARITY:NONE

SAVE232 Saves all RS-232 parameters to EEPROM.

EXAMPLE: SAVE232

3.4.5.4 Miscellaneous Commands

EDIT:ON/OFF Enters or exits the Edit mode. If set to ON, the Edit mode will allow changes to be made to all parameters without the actual pulse outputs changing. All pulse outputs will then be updated to the current parameters when the Edit mode is exited by sending OFF.

EXAMPLES: EDIT:ON
EDIT:OFF

SET:n Selects one of the forty stored setups and updates all pulse parameters to the stored values. "n" must be in the range 0 through 39.

EXAMPLES: SET:0
SET:39

SAVEBLS Saves setups 0 through 4 into EEPROM for permanent storage. These five setups will then be present after the next power-up cycle.

EXAMPLE: SAVETBLS

LOADTBLS Load setups 0 through 4 from EEPROM. This operation is automatically done during power up, but it can also be used to restore the first five setups to the power up state at any time.

EXAMPLE: LOADTBLS

SAVET0 Saves the present T0 delay value of each channel to EEPROM for permanent storage.

EXAMPLE: SAVET0

PROTECT:n Sets the error protect mode to "n", where "n" may be a value 1 through 3.

EXAMPLES: PROTECT:1
PROTECT:3

RESET Causes the firmware to jump to the start of its program.

EXAMPLE: RESET

SAVECS: [password] Stores the checksums of the clock board and all channel boards in the EEPROM.

EXAMPLE: SAVECS: xxxxx

NEWEE: [password] Reformats the EEPROMs. SAVECS must be executed immediately after this command.

EXAMPLE: NEWEE: xxxxx

3.4.5.5 Commands Which Return Data From the Instrument

EXTTRIG? Returns the state of the external trigger. The word ON or OFF will be returned to the controller.

EXAMPLE: EXTTRIG?
returns: ON (ext. triggered)
or: OFF (int. triggered)

CHTRIG? Returns the state of all of the external channel trigger sources.

EXAMPLE: CHTRIG?
returns: 1-ON:2-OFF:3-OFF:4-ON

PER? Returns the period of the internal clock.

EXAMPLE: PER?
returns: 23.70n

BURSTCT? Returns the number of pulses programmed for each burst.

EXAMPLE: BURSTCT?
returns: 5

BURST? Returns the state of the Burst mode. The word ON or OFF will be returned to the controller.

EXAMPLE: BURST?
returns: ON

CH? Returns the default channel number to be used in all channel related commands unless explicitly stated otherwise.

EXAMPLE: CH?
returns: 1

DLY?[:c] Returns the delay value for the desired channel. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: DLY?
or: DLY?:2
returns: 5.600n

WID?[:c] Returns the width value for the desired channel. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: WID?
or: WID?:3
returns: 234.0n
or: 56.00m

LED?[:c] Returns the leading edge value for the desired channel. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: LED?
or: LED?:4
returns: 1.000u
or: 12.40n

TED?[:c] Returns the trailing edge value for the desired channel. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: TED?
or: TED?:1
returns: 45.60u
or: 2.400n

VHI?[C;] Returns the VHI value for the desired channel. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: VHI?
or: VHI?:2
returns: 2.340
or: -534.0m

VLO?[:c] Returns the VLO value for the desired channel. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: VLO?
or: VLO?:3
returns: -1.500
or: 300.0m

DBL?[:c] Returns the state of the Double Pulse Mode for the desired channel. The word ON or OFF will be returned. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: DBL?
or: CBL?:1
returns: ON
or: OFF

INV?[:c] Returns the state of the Invert Mode for the desired channel. The word ON or OFF will be returned. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: INV?
or: INV?:4
returns: ON
or: OFF

T0?[:c] Returns the value of the T0 delay for the desired channel. If the optional channel parameter is omitted, the default channel number will be used.

EXAMPLES: T0?
or: T0?:2
returns: 3.500n
or: 4.000n

GETCHAN?[:c] Returns the complete programmed values for one channel in the present setup. If the optional channel parameter is omitted, the default channel number will be used. This command gives the instrument the ability to send a string to the controller that may be recalled later in order to duplicate the present setup.

EXAMPLES: GETCHAN?
or: GETCHAN?:3
returns: CH:1;DLY:10.00n;WID:10.00n;
LED:5.000n;TED:1.250n; VHI:2.500;
V LO:1.000; DBL:OFF; INV: ON

PPLBIT? Returns the value of the Parallel Poll Bit on the IEEE-488 bus. The value returned will be 0 through 8.

EXAMPLE: PPLBIT?
returns: 1
or: 8

DEVICE? Returns the device address on the IEEE-488 bus. The value returned will be 0 through 30.

EXAMPLE: DEVICE?
returns: 5
or: 27

PONCLR? Returns the state of the Power-On-Clear flag. The word ON or OFF will be returned.

EXAMPLE: PONCLR?
returns: ON
or: OFF

BAUD? Returns the RS-232 baud rate. The returned value will be 110, 300, 1200, 2400, 4800, 9600, or 19200.

EXAMPLE: BAUD?
returns: 300
or: 9600

DATA? Returns the number of data bits used with the RS-232 interface. The returned value will be 4,5,6, or 8.

EXAMPLE: DATA?
returns: 5
or: 8

STOP? Returns the number of stop bits used with the RS-232 interface. The returned value will be 1, 1.5, or 2.

EXAMPLE: STOP?
returns: 2
or: 1

PARITY? Returns the parity used with the RS-232 interface. The returned word will be NONE, EVEN, or ODD.

EXAMPLE: PARITY?
returns: EVEN
or: NONE

SET? Returns the current setup number. The value returned will be in the range 0 through 39.

EXAMPLE: SET?
returns: 2
or: 29

CALHIST? Returns the serial numbers and calibration dates (month, day, year) for the clock board and each of the installed channel boards.

EXAMPLE: CALHIST?
returns: CLK SER#1234,013084
CH1 SER#2345, 020184
CH2 SER#3456, 123183
CH3 SER#4567, 090184
CH4 SER#4568, 090184

SYSTEST? Executes a system test and returns the status of any test which failed, if any. A test heading and a completion message are always sent regardless of any failures.

EXAMPLE: YSTEST?
returns: SYSTEM TEST — SPG VERS X.X
CLOCK CHAIN FAILED
SYSTEM TEST COMPLETE

PROTECT? Returns the current error protect mode. The value will be 1, 2, or 3.

EXAMPLE: PROTECT?
returns: 1
or: 3

SECTION 4
MAINTENANCE

4.1 PERFORMANCE VERIFICATION PROCEDURE

NOTE

Breaking the quality assurance seal may void your warranty.

The following procedure checks parameter accuracy and can be used for yearly performance checks.

Modules are placed inside the instrument in a specific order. Before testing, identify the location of the options installed (paragraph 1.3) and perform the proper test for that option.

4.1.1 Test Equipment Required

Table 2-2 lists the test equipment and the minimum equipment specifications required to perform the performance verification procedure. The performance and accuracy requirements of the test equipment should be 3 to 10 times better than the equipment under test. Substitution of any test equipment in this list is acceptable, provided it meets and/or exceeds this accuracy requirement.

4.1.2 Functional Check

1. Connect the Models 2000 and waveform analyzer as shown in figure 2-4. **All outputs of the Model 2000 (except TO) should be terminated into 50Ω.**

   CAUTION

   Care should be taken to insure that each pulse channel output is terminated with a 50 ohm load at any time ac power is present.

2. Turn both units on and allow the waveform analyzer to warmup for a few minutes. The Model 2000 does not need a warmup period, but none of the outputs are active until it has completed its selftest routine.

3. When the Model 2000 is shipped from the factory, each channel has been set to a standard turn-on program setting. Verify the settings on the unit with the listing below. To change the settings, position the cursor over the value you wish to change, enter the new value and press one of the terminator keys.

   Example: to set the period to 100 nanoseconds (ns) press the "1", "0", "0", and "NANO" keys.

4. Verify the following Model 2000 settings:

External CLK Trigger	OFF
Channel Clock EXT triggers	OFF
Burst	OFF
Internal Period	100ns

5. Verify the following settings for each channel:

Delay	10.00ns
Width	10.00ns
Vlow	0.0V
Inv	OFF
Dbl	OFF
Protection Level	1
Setup	00

Setting for 2002FE Module

Vhi	2.0V

Setting for 2005FE Module

Vhi	5.0V

Settings for 2005/2005E Modules

Lead	0.9ns
Trail	0.9ns
Vhi	5.0V

Settings for 2010/2010E Modules

Lead	1.8ns
Trail	1.8ns
Vhi	10.0V

6. Adjust the oscilloscope to display a full cycle of the waveform.

7. Measure the pulse period. The period should be 98 to 102 ns.

8. Measure the pulse width. The pulse width should be 8.8 to 11.2 ns.

9. Measure the amplitude (Vhi-Vlow).

Module	Measured Value	
	Min	Max
2002FE	1.945V	2.055V
2005	4.875	5.125V
2005E	4.875	5.125V
2005FE	4.875	5.125V
2010	9.75	10.25V
2010E	9.75	10.25V

10. Align the leading edge of the pulse with one of the graticule lines on the oscilloscope (timebase set to 5ns/Div). Measure the delay. Change the Delay setting to 20ns. Change in delay should measure 9.3 to 10.7 ns.

11. Repeat steps 6 through 10 for each additional channel.

4.1.3 Instrument Performance Check

4.1.3.1 Initial Setup

All outputs of the instrument should be terminated into 50Ω. Modify the settings as follows:

External CLK Trigger	OFF
Channel Clock EXT Triggers	OFF
Burst	OFF
Internal Period	10.000ns

Set each channel as shown below:

Delay	2.000 ns
Width	4.000 ns
Vlow	0.000V
Inv	OFF
Dbl	OFF
Protection Level	1
Setup	00

Setting for 2002FE Module

Vhi	2.0V

Setting for 2005FE Module

Vhi	5.0V

Settings for 2005/2005E Modules

Lead	0.9ns
Trail	0.9ns
Vhi	5.0V

Settings for 2010/2010E Modules

Lead	1.8ns
Trail	1.8ns
Vhi	10.0V

4.1.3.2 Clock Check

1. Connect the Model 2000 and the frequency counter as shown in figure 2-4.

2. Measure the pulse period. The period should be 9.8 to 10.2 ns.

3. For the table below, change the pulse generator period to the value in the left column and verify the output of channel 1 is within the "Min" and "Max" readings.

Internal Period Setting	Frequency Counter Reading	
	Min	Max
50ns	49.0ns	51.0ns
100ns	98ns	102ns
500ns	490ns	510ns
1µs	980ns	1.02µs
50µs	49.0µs	51µs
100µs	98µs	102µs
500µs	490µs	510µs
1ms	980ms	1.02ms
50ms	49.0ms	51ms
100ms	98ms	102ms
500ms	490ms	510ms
1s	980ms	1.02s

4. Modify the Model 2000 settings as follows:

Burst	ON
Count	00010
Internal Period	100ns
Width	50ns

5. Move the cursor to the right of "Start?". To initiate a burst depress the "ENTER" key. Verify with the counter that the Model 2000 puts out a burst of 10 pulses.

6. Change the burst count to various numbers between 1 and 65535 and verify the output (maximum count depends on the frequency range).

7. Change the Model 2000 Burst setting to OFF.

4.1.3.3 Width Check

1. Modify the Model 2000 settings to those given in paragraph 4.1.2.

2. Modify the Model 2000 settings as follows:

Internal Period	500ns
Width	15ns

3. Use the waveform analyzer and oscilloscope to measure the pulse width. The pulse width should be 13.7 to 16.3ns.

4. Use the following table to check the width settings.

Width Setting	Measured Value	
	Min	Max
30ns	28.4ns	31.6ns
120ns	117.6ns	122.4ns
150ns	146ns	154ns
200ns	195ns	205ns

5. Change the Model 2000 Internal Period setting to 100.0µs

6. Use the following table to check the width settings.

Width Setting	Measured Value	
	Min	Max
2µs	1.959µs	2.041µs
5µs	4.899µs	5.101µs
25µs	24.499µs	25.501µs

7. If the instrument is not equiped with the extended range option, skip to paragraph 4.1.3.4. If unsure as to option, try to enter 50µs. If the unit responds by changing the width, the option is present.

8. To check the extended range calibration, change the instrument Internal Period setting to 1.000ms.

9. Use the following table to check the width settings.

Width Setting	Measured Value	
	Min	Max
50µs	47.499µs	52.501µs
300µs	284.999µs	315.001µs

10. Change the Internal Period setting to 1.000s.

11. Use the following table to check the width settings.

Width Setting	Measured Value	
	Min	Max
4ms	3.80ms	4.20ms
10ms	9.50ms	10.5ms
80ms	76ms	84ms
100ms	95ms	105ms
500ms	475ms	525ms
900ms	855ms	945ms

4.1.3.4 Delay Check

Note that there is a minimum delay in protection level 1 of 2 ns ±1ns with respect to T0. The delay to the first pulse in the double pulse mode is 0ns ±1ns.

1. Match the instrument settings to those given in paragraph 4.1.2.

2. Change the Internal Period setting to 500.0ns.

3. Use the waveform analyzer and oscilloscope to measure the delay from T0 to the 50% point of the leading edge of the pulse. The delay should be 8.8 to 11.2ns.

4. Use the following table to check the delay settings.

Delay Setting	Measured Value	
	Min	Max
15ns	13.7ns	16.3ns
30ns	28.4ns	31.5ns
120ns	116.6ns	123.4ns
150ns	146ns	154ns
200ns	195ns	205ns

5. Modify the Model 2000 settings as folllows:

Internal Period	100.0µs
Width	100.0ns

6. Use the following table to check the delay settings.

Delay Setting	Measured Value	
	Min	Max
2µs	1.959µs	2.041µs
5µs	4.899µs	5.101µs
25µs	24.499µs	25.501µs

7. If the instrument is not equipped with the extended range option, skip to paragraph 4.1.3.5. If unsure as to option try to enter 50 µs. If the unit responds by changing the delay, the option is present.

8. To check the extended range calibration, modify the Internal Period settings to 1.000ms.

9. Use the following table to check the delay settings.

Delay Setting	Measured Value	
	Min	Max
50µs	47.499µs	52.501µs
300µs	284.999µs	315.001µs

10. Change the Internal Period setting to 1.000s.

11. Use the following table to check the delay settings.

Delay Setting	Measured Value	
	Min	Max
4ms	3.8ms	4.2ms
10ms	9.50ms	10.5ms
80ms	76ms	84ms
100ms	95ms	105ms
500ms	475ms	525ms
900ms	855ms	945ms

4.1.3.5 Leading/Trailing Edge Check

1. Match the instrument settings to those given in paragraph 4.1.2.

2. Modify the settings as follows:

Delay	5.000ns
Width	50.00ns
Lead/Trail	0.876ps

NOTE
For modules 2002FE and 2005FE, skip to step 9.

3. Use the waveform analyzer and oscilloscope with S-6 sampling head and 50Ω terminator to verify the leading and trailing edges. All measurements are 10% to 90%.

Module	Specification
2005	<1ns
2005E	<1ns
2010	<2ns
2010E	<2ns

4. Use the following table to check the leading and trailing edges for the 2005, 2005E, 2010 and 2010E Modules.

Lead/Trail Setting	Measured Value	
	Min	Max
12ns	10.76ns	13.24ns
15ns	13.7ns	16.3ns

5. Modify the settings as follows:

Internal Period	10.00µs
Delay	300.0ns
Width	600.0ns

6. Use the following table to check the leading and trailing edges.

Lead/Trail Setting	Measured Value	
	Min	Max
100ns	97ns	100ns
200ns	195ns	205ns
250ns	244ns	256ns

7. Modify the settings as follows:

Internal Period	50.00µs
Delay	7.500µs
Width	12.50µs

8. Use the following table to check the leading and trailing edges.

Lead/Trail Setting	Measured Value	
	Min	Max
1µs	979ns	1.021µs
2µs	1.959µs	2.041µs

NOTE
For modules 2005, 2005E, 2010 and 2010E, skip to paragraph 4.1.3.6.

9. Use the waveform analyzer and oscilloscope with S-6 sampling head and 50Ω terminator to measure the edges. Measurements for the 2005F module are 10% to 90%. Measurements for the 2002F module are 20% to 80%.

Module	Specification
2002FE	<320 ps
2005FE	<550 ps

4.1.3.6 Amplitude Check

1. Match the Model 2000 settings to those given in paragraph 4.1.2.

2. Modify the settings as follows:

Internal Period	10.00µs
Width	50.00ns

3. Use the waveform analyzer and oscilloscope to measure the pulse amplitude for the 2002FE Module.

Vhi Setting (Vlow = 0V)	Measured Value	
	Min	Max
1.5V	1.455V	1.545V
1.0V	965 mV	1.035V

4. Use the waveform analyzer and oscilloscope to measure the pulse amplitude for the 2005, 2005E and 2005FE Modules.

Vhi Setting (Vlow = 0V)	Measured Value Min	Max
2.5 V	2.425 V	2.575 V
2.0 V	1.935 V	2.065 V
1.25 V	1.2 V	1.3 V
750 mV	710 mV	790 mV
625 mV	587 mV	658 mV
500 mV	465 mV	535 mV
313 mV	282 mV	344 mV

5. Use the waveform analyzer and oscilloscope to measure the pulse amplitude for the 2010 and 2010E Modules.

Vhi Setting (Vlow = 0V)	Measured Value Min	Max
5 V	4.85 V	5.15 V
2.5 V	2.4 V	2.6 V
2.0 V	1.91 V	2.09 V
1.25 V	1.175 V	1.325 V
750 mV	685 mV	815 mV
625 mV	537 mV	688 mV

4.1.3.7 Double Pulse Spacing Check

1. Match the Model 2000 settings to those given in paragraph 4.1.2.

2. Modify the settings as follows:

Internal Period	20.00ns
Delay	5.000ns
Width	2.000ns
Dbl	ON

3. Use the waveform analyzer and oscilloscope to display the pulses. Verify the presence of two complete pulses.

4.1.3.8 Clock Board Check

CAUTION

Care should be taken to insure that each pulse channel output is terminated with a 50 ohm load at any time ac power is present. Apply power to the test equipment and allow it to warm up. The Model 200 requires no warmup time but signals will not be present at the outputs until completion of the selftest procedure.

1. Using the oscilloscope, verify the internal clock output at J109 (CLOCK) and the T0 output at J108 are functional at the levels specified below.

J109 CLOCK output	50% duty cycle.
	>+1.0 V into 50 ohms.
	>+2.0 V into high impedance.
J108 T0 output	Positive edge at time T0
	1-4ns width, freq. dep.
	>+1.0 V into 50 ohms.
	>+2.0 V into high impedance.

2. Set the Model 2000 as follows:

Extend CLK Trigger	OFF
Channel Clock EXT Triggers	OFF
Burst	OFF
Internal Period	50 ns

3. Set each channel as follows:

Delay	10ns
Width	25ns
Lead and Trail	2ns
Vhi	5V
Vlow	0V
Inv and Dbl	OFF

4. Using the oscilloscope, verify the operation of each pulse channel output — connectors J101 through J104.

5. Change the Model 2000 External CLK Trigger setting to ON.

6. Using the oscilloscope, adjust the pulse generator to produce a positive pulse into 50 ohms with the following characteristics:

Baseline	0V	Pulse top	1.5V
Period	50ns	Width	5ns to 25ns
Delay	Min.	Lead/Trail	Min.

7. Connect the output of the pulse generator to J113 on the rear panel of the Model 2000. This is the CLOCK EXTERNAL DRIVE input.

8. Using the oscilloscope, verify that channel 1 of the Model 2000 is producing a pulse output. It is unnecessary to check the other outputs.

9. Modify the Model 2000 settings as follows:

External channel trigger(s)	ON
External CLK Trigger	OFF or ON

10. Using the oscilloscope, adjust the pulse generator to produce a positive pulse into 50 ohms with the following characteristics:

Baseline	-1.3V	Pulse top	-0.3V
Period	50ns	Width	25ns
Delay	Min	Lead/Trail	Min.

11. Connect the pulse generator to J114 CHAN. 1 EXTERNAL DRIVE.

12. Using the oscilloscope, verify the operation of pulse output channel 1 at J101 CHAN. 1 OUTPUT.

13. Repeat steps 11 and 12 to verify any additional channels using the table below.

External Drive Input	Pulse Output Channel
J115 CHAN. 2	CHAN. 2 OUTPUT
J116 CHAN. 3	CHAN. 3 OUTPUT
J117 CHAN. 4	CHAN. 4 OUTPUT

4.1.3.9 Jitter Measurement

1. Use the 7T11 and 7S11 plug-ins with the S-2 module. Adjust the settings as follows:

7T11 Settings

SWEEP RANGE	1ns
SCAN	REP
TRIG SLOPE	+
TIME POSITION	Max. CW
TRIG AMP	X1
Press:	SEQUENTIAL
	EXT 50Ω

7S11 Settings

VARIABLE	100
DOT RESPONSE	NORMAL
Press:	+UP

2. Match the Model 2000 settings to those given in paragraph 4.1.2.

3. Modify the Model 2000 settings as follows:

Internal Period	10ns
Delay	2ns
Width	5ns
Vlow	0V
Vhi	5V
Lead	880ps
Trail	880ps

4. Connect the Model 2000 channel 1 output through a X10 50Ω attenuator to the S-2 Sampling Head.

5. Connect the Model 2000 clock output through a X10 50Ω attenuator to the 7T11 Sampling Sweep Unit at "TRIG INPUT".

6. Adjust the 7T11 TRIG LEVEL for a stable triggered display.

7. Change the 7S11 VARIABLE setting to "10".

8. Rotate the 7T11 SWEEP RANGE control CCW until five positive-going edges are shown.

9 Record the width of the horizontal jitter on the fifth positive-going edge. Divide this number by 5 to obtain the jitter reading. Maximum allowable jitter is 27ps.

4.2 ALIGNMENT/CALIBRATION

NOTE

Breaking the quality assurance seal may void your warranty.

Field or customer alignment of the instrument is not possible. If realignment is required, return the instrument to the factory for service. Before returning the instrument, contact the Customer Service Department by calling or writing to:

Wavetek San Diego, Inc.
9045 Balboa Ave.
San Diego, CA 92123
Telephone: (619) 279-2200
TWX: (910) 335-2007

4.3 TROUBLESHOOTING

NOTE

Breaking the quality assurance seal may void your warranty.

If a problem develops within the instrument, Wavetek advises returning the instrument to the factory. However, a set of schematics and related documentation is available for those circuits not critical to instrument alignment. This packet may be obtained at a nominal fee by contacting the factory (see paragraph 4.2).

Manuals Plus

2002 Bethel Road
Suite 105
Finksburg, MD 21048

Invoice

Date	Invoice #
6/8/2011	8447

Bill To	Ship To
Value Tronics International 1675 Cambridge Elgin, IL 60123	Value Tronics International PO# 218473 1675 Cambridge Elgin, IL 60123

P.O. Number	Terms	Ship	Via
219777	Net 30	6/8/2011	UPS

Quantity	Description	Price Each	Amount
1	Agilent (HP) 37704A Operators Manual - Fair p/n 37704-90004	40.00	40.00T
1	Analogic 6100B Service Manual - Fair p/n 82-5082	45.00	45.00T

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